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THE ATCHAFALAYA RIVER DELTA

Report 2
FIELD DATA

SECTION 3: GRAIN SIZE ANALYSIS OF SELECTED BAY SEDIMENTS

by

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The Wax Lake Outlet and Lower Atchafalaya River deltas in Louisiana have grown dramatically. Concern for the impact of this growth has led the US Army Corps of Engineers to conduct an investigation to predict how the deltas will evolve over the next 50 years and to determine the impacts of that growth on navigation, flood control, salinity, and sedimentation. Within this series of reports, this section documents field and laboratory studies and analysis on the gradation of selected bay sediments. Members of the US Army Engineer District, New Orleans; US Army Engineer Waterways Experiment Station (WES) Hydraulics Laboratory; and the Louisiana State University (LSU) performed the study.

Core and grab samples were taken by LSU and returned to WES for geotechnical testing and analysis. A part of this work has been previously reported in Section 1, "Atchafalaya Bay Program Description and Data," in two volumes, and in Section 2, "Settling Characteristics of Bay Sediments." This section will emphasize the grain size analysis of (over)

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19. ABSTRACT (Continued).

approximately 325 samples taken within the bay system and tributaries. The results of this analysis ultimately became the data for several of the numerical model studies conducted and reported within this series of reports and other independent studies conducted at LSU under contract with the New Orleans District.

Keywords; Lou[illegible]; [illegible]; Sedimentology; Mathematical [illegible]; Flood Control; Salinity; (KR) [illegible]

PREFACE

The work reported herein was performed in the Hydraulics Laboratory (HL) of the US Army Engineer Waterways Experiment Station (WES) as a part of the overall investigation to predict the evolution of the Atchafalaya Bay delta. The study design (Phase I of the study) was authorized by the US Army Engineer District, New Orleans (LMN), on 18 July 1977. The implementation of the study plan (Phase II) was authorized by LMN on 21 May 1979. This report presents work done under Phase II in 1981 through 1983, in support of numerical modeling of the delta evolution.

This study was conducted under the direction of Messrs. H. B. Simmons and F. A. Herrmann, Jr., former and present Chiefs, HL; R. A. Sager, Assistant Chief, HL; W. H. McAnally, Jr., Chief, Estuaries Division; G. M. Fisackerly, Chief, Estuarine Processes Branch; and R. A. Boland, former Chief, Hydrodynamics Branch. The plan of study of which this task is one part was developed by Messrs. McAnally and S. B. Heltzel, Estuarine Engineering Branch. This study and analysis were performed by Messrs. Allen M. Teeter, Estuarine Processes Branch, and S. A. Adamec, now with the Information Technology Laboratory, WES. Dr. John Wells, formerly of the Louisiana State University, Baton Rouge, LA, arranged and conducted the field sample collection, and Mr. J. C. Oldham, Geotechnical Laboratory, supervised the laboratory testing. This report was written by Mr. W. Pankow, Estuarine Processes Branch, Messrs. Teeter and Adamec, and Ms. B. P. Donnell, Estuarine Simulation Branch, who is currently the Principal Investigator of the project. The authors wish to acknowledge and thank Ms. Melinda Wooley for her work with the data files and the resulting tabular format for this report.

Commander and Director of WES during preparation of this report was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
inches	2.54	centimetres
inches	25.40	millimetres
inches	0.000254	microns
miles (US statute)	1.609347	kilometres
tons (2,000 pounds, mass)	907.1847	kilograms

THE ATCHAFALAYA RIVER DELTA

FIELD DATA

Section 3. Grain Size Analysis of Selected Bay Sediments

PART I: INTRODUCTION

Background

1. The main sediment source to the Atchafalaya Bay system is the Atchafalaya River. The river captures about 30 percent of the latitude flow (combined flow of the Mississippi River and Red River at the latitude of 31° N) at the Old River Control Structures (Figure 1), and carries with it an average of about 100 million tons* of sediment in suspension each year. Fine-grained sediments predominate in the Atchafalaya Bay system. Over the past several decades, the suspended sediment has filled in the Atchafalaya basin floodway between its natural levee systems and is now depositing rapidly in Atchafalaya Bay (Figure 1). As shown, two deltas are forming in Atchafalaya Bay: at the mouth of Lower Atchafalaya River and at Wax Lake Outlet (WLO). The evolving deltas became subaerial in 1973 and have since become one of the most dynamic currently active delta systems in the world.

2. The evolving deltas have converted shallow bays into marshes and continue to generate a great deal of interest in deltaic processes. The primary benefit from these two deltas has been the addition of new land to the coast of Louisiana in areas otherwise experiencing land loss. The primary concerns with the evolving deltas have been siltation in the navigation channels and backwater flooding in the surrounding low-lying coastal parishes of southern Louisiana.

3. Phenomenal growth of the subaerial lower Atchafalaya River delta and the emerging WLO delta led the US Army Engineer District, New Orleans, to request that the US Army Engineer Waterways Experiment Station (USAEWES) conduct an investigation to predict future growth of the deltas and effects of that growth. The New Orleans District had previously contracted with the Louisiana State University (LSU), Baton Rouge, LA, to conduct several

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

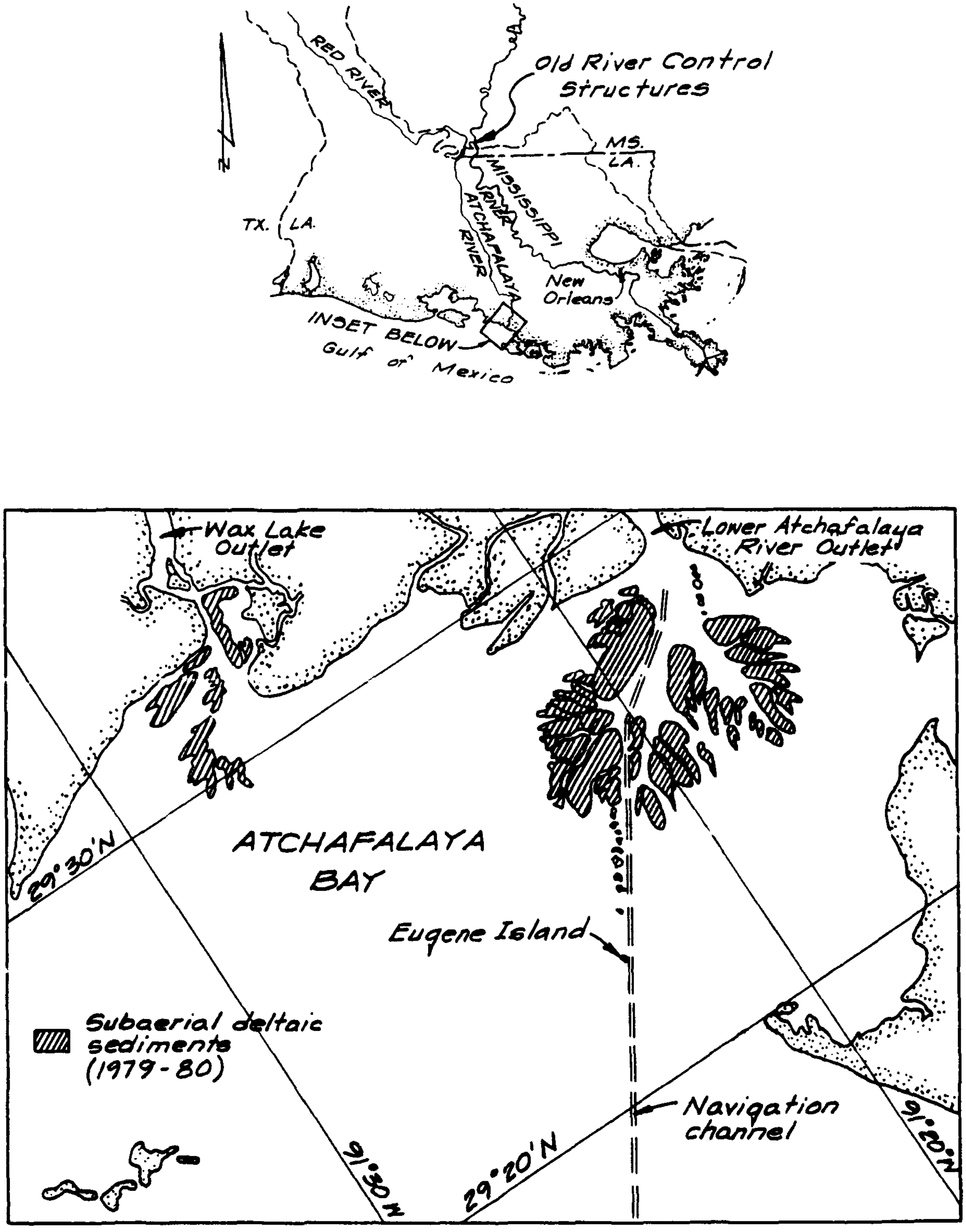

Figure 1. Vicinity sketch showing the Atchafalaya River and Wax Lake Outlet deltas

environmental studies within the Atchafalaya Bay system.

4. A brief discussion of the historical development and long-term future projection of the Atchafalaya River delta is presented in Reports 3 and 7 of this series (Letter, 1982 and Wang, 1985). The report discusses the events prior to the 1950's, the increase of flows through the Atchafalaya River from the Mississippi River with correspondingly increased suspended sediments in the 1960's, and growth of the delta through the early 1970's.

Objective

5. The overall objective of the Atchafalaya Bay investigation is to predict future evolution of the delta system. Specific answers are sought to these questions:

a. For existing conditions and no actions other than those already practiced (i.e., maintenance of navigation channels), how will delta deposits evolve over the short-to-medium term (10-15 years) and the long term (50 years)?

b. How will the delta's evolution affect:

(1) Flood stages?
(2) Maintenance dredging of the navigation channel?
(3) Salinity, sedimentation, and circulation in the Atchafalaya Bay system?

c. What would be the impact of various navigation/flood-control structural alternatives on all of the above?

6. This report summarizes studies conducted by the USAEWES Hydraulics Laboratory to characterize sediments depositing in Atchafalaya Bay, Louisiana. These studies were undertaken as part of a comprehensive investigation of the deltaic evolution occurring in Atchafalaya Bay. Objectives were to describe field conditions and to generate information required by USAEWES numerical sediment transport modeling effort for the prediction of deltaic evolution. The depositional properties of sediments were the primary subject. These properties include the settling velocity distributions of sediments found both in suspension and in bed deposits, the concentration of newly deposited sediments, and the rates of consolidation of newly deposited bed sediments. A portion of the work in this program has previously been reported in Section 1: Atchafalaya Bay Program Description and Data by Coleman et al. (1988), and in Section 2: Settling Characteristics of Bay Sediments, by Teeter and Pankow (1989). This report will address the

collection of bed core and bottom grab samples, laboratory testing/gradation, and the analysis of the results.

Approach

7. Because the bay system is so complex, a large number of samples in multiple locations were required in order to characterize the sediments both locally and overall. Furthermore, samples of sediment deposits along the bank and marsh areas were required in addition to the navigation channel bottom in order to determine deposition rates and other variables.

8. To minimize the labor-intensive field efforts, the Center for Wetland Resources of LSU performed the necessary field work during other field activities and forwarded the bed grab samples to the USAEWES Geotechnical Laboratory (GL) for testing. Upon completion of the sieve analysis, gradation curves were prepared for each sample and forwarded to the HL for analysis and characterization of the sediments. The resulting data, combined with other sediment, tide, salinity, and other data (Coleman 1988), became input data for the various numerical models applied to simulate the conditions within the bay.

PART II: SAMPLING LOCATIONS AND FIELD PROCEDURES

9. LSU conducted most of the field sampling operations during the period of April 1980 through July 1981 with emphasis during the winter of 1980 and early summer 1981. Figures 2a and 2b indicate the approximate locations in the bay where samples were taken. There were approximately 750 samples taken from 500 stations although only 325 were used for this study with the remainder used by the LSU studies. Many of the station locations had to be modified from the initial plan due to the shallow depths and existence of wrecked vessels or recently constructed oil platforms. The stations were located by latitude and longitude on contour maps previously prepared by the from bottom condition surveys. The mapped area was further identified using USGS topographic quadrangle sheets with X and Y coordinates. Field personnel set a series of 4 targets (indicated on Figure 2) in the area so that range finders and triangulation could be used to locate sampling stations by personnel operating the small craft.

Sampling Station Locations

10. As previously noted, the relative sampling locations and field located targets are shown in Figure 2. The latitude and longitude were used to locate the stations; however, an X and Y system was also required, not only for field use but also for numerical model grid generation. Four geographic points with known latitude and longitude were used as control points for digitizing sampling locations. The grid system used was the Louisiana State Coordinate System, and personnel of the USGS Baton Rouge field office assisted with the computation of the fixed points.

Survey Control Points

Location	Latitude	Longitude	X	Y
Halter's Island Point	N 29' 23.57'	W 91' 13.42'	2,034,920	264,087
Point Au Fer	N 29' 19.88'	W 91, 21.18'	1,992,733	241,706
Belle Island Point (N.E. stack)	N 29' 31.76'	W 91' 23.63'	1,980,759	313,711
Ann Channel Wreck	N 29' 23.98'	W 91' 27.0'	1,962,848	266,573

The east-west aligned reef system extending from Point Au Fer has been both mined and eroded to the extent that it no longer is visible even at low tide.

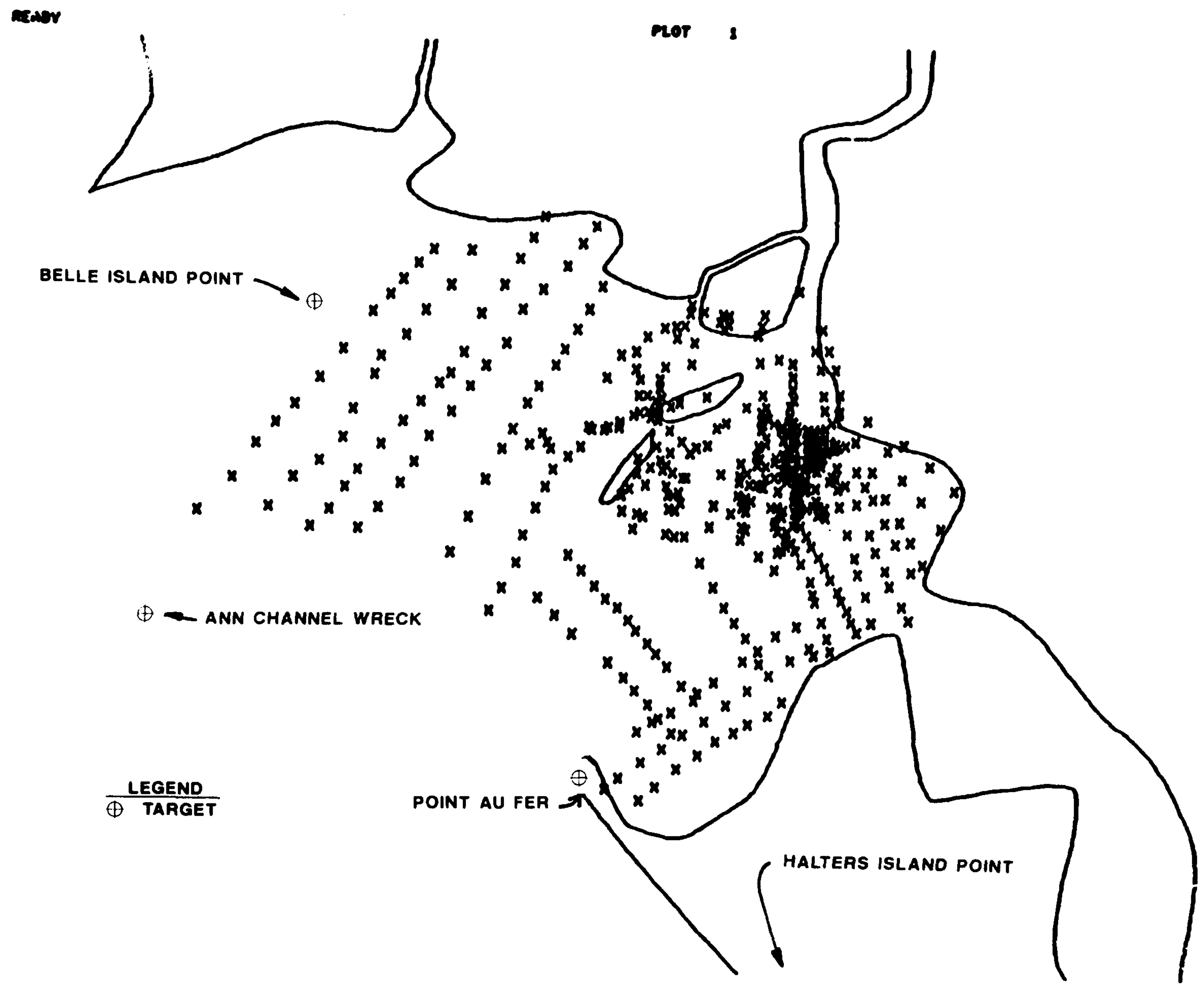

Figure 2a. Sample locations

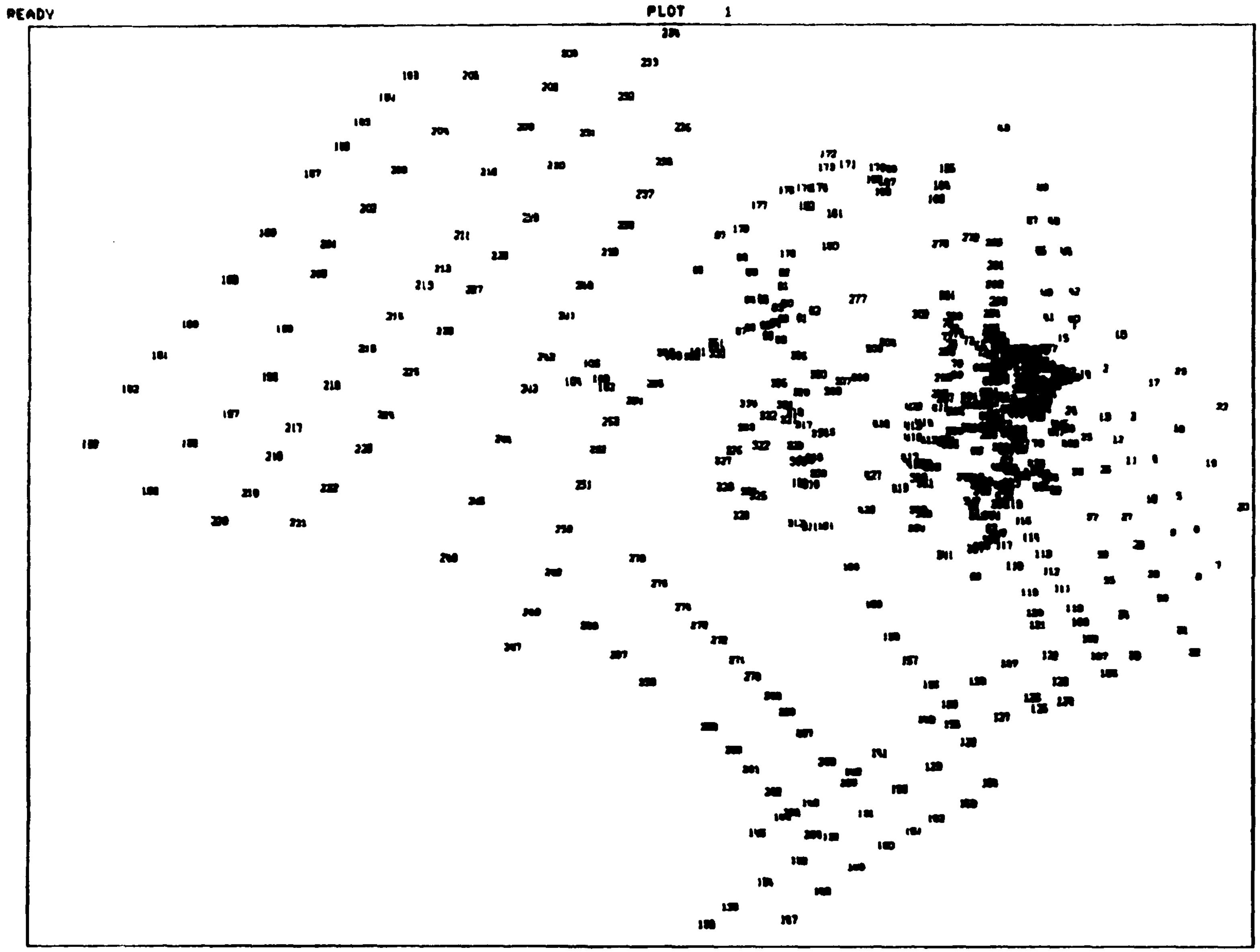

Figure 2b. Sample location numbers

Sample Collection and Handling

11. Surficial samples representing the top 3 in. of bed sediments were collected. A Shipek sampler was used for most samples. Figure 3 is a photograph of a typical small grab sampling device similar to that used. In some of the very shallow marshy areas however, personnel could only approach the site with a small boat and wade to the designated station using a gardener's spade to obtain a sediment sample. The samples were placed in plastic bags, sealed, and tagged with the station number and date collected. After returning to LSU, the samples were placed in boxes and shipped to the USAEWES for analysis. The samples were collected at periods of high and low riverflow to indicate seasonality. In total, about 1,000 samples were collected.

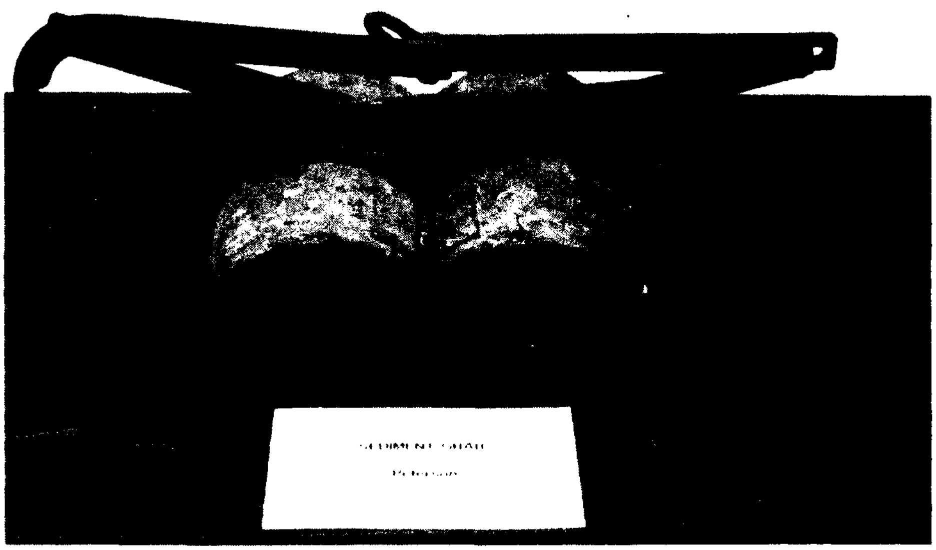

Figure 3. A Peterson type grab sampling devices that is similar in design to the Shipek sampler used

PART III: GRADATION TESTING AND ANALYSIS

12. As previously mentioned, the sample sieve analyses were conducted by the USAEWES GL. The standard sample handling and sieve analysis methods used are presented in USAEWES, 1960, and will not be detailed here. Standard dry sieving and hydrometer tests were performed on the coarse and fine fractions (respectively) of the samples.

13. The stations were digitized and the locations entered into a computer (Figure 2a). Grain size percent finer classes of the samples were computed, and will be discussed in the next section of this report.

Grain Size Analysis Methods

14. Gradation curves for each sample were digitized. The data stored from each of these samples included sample number, location, date tested, and points D_5 through D_{95} for the curve. The gradation curve (and any desired D_x value) could be reconstructed through simple interpolation. Figure 4 shows a composite grain size distribution for the entire bay that was generated from an average of all available samples (Thomas et al. 1988). Of particular interest is the fact that sands, silts and clays are all actively transported in the evolution of the delta. The spatial distribution and predominance of sands and clays (in different areas of the bay) was used to verify the output of the numerical sediment transport model.

Reported by Others

15. Wu (1986) reported on several aspects of the overall study, but was directed toward water quality conditions that were being studied by LSU. Wu selected 563 bottom sediment samples and placed them into 3 separate sets to "determine the natural grouping of the sediments in Atchafalaya Bay". The three sets included 140 samples collected over the entire bay during the summer of 1980, and two sets of 212 samples each collected during January and May 1981 on both the east and west sides of the navigation channel to determine seasonality effects. The data sets were then treated by cluster analysis and nonparametric statistical methods to determine and quantify the influx grain size versus seasonal effects. The study conducted by Wu (1986) provided

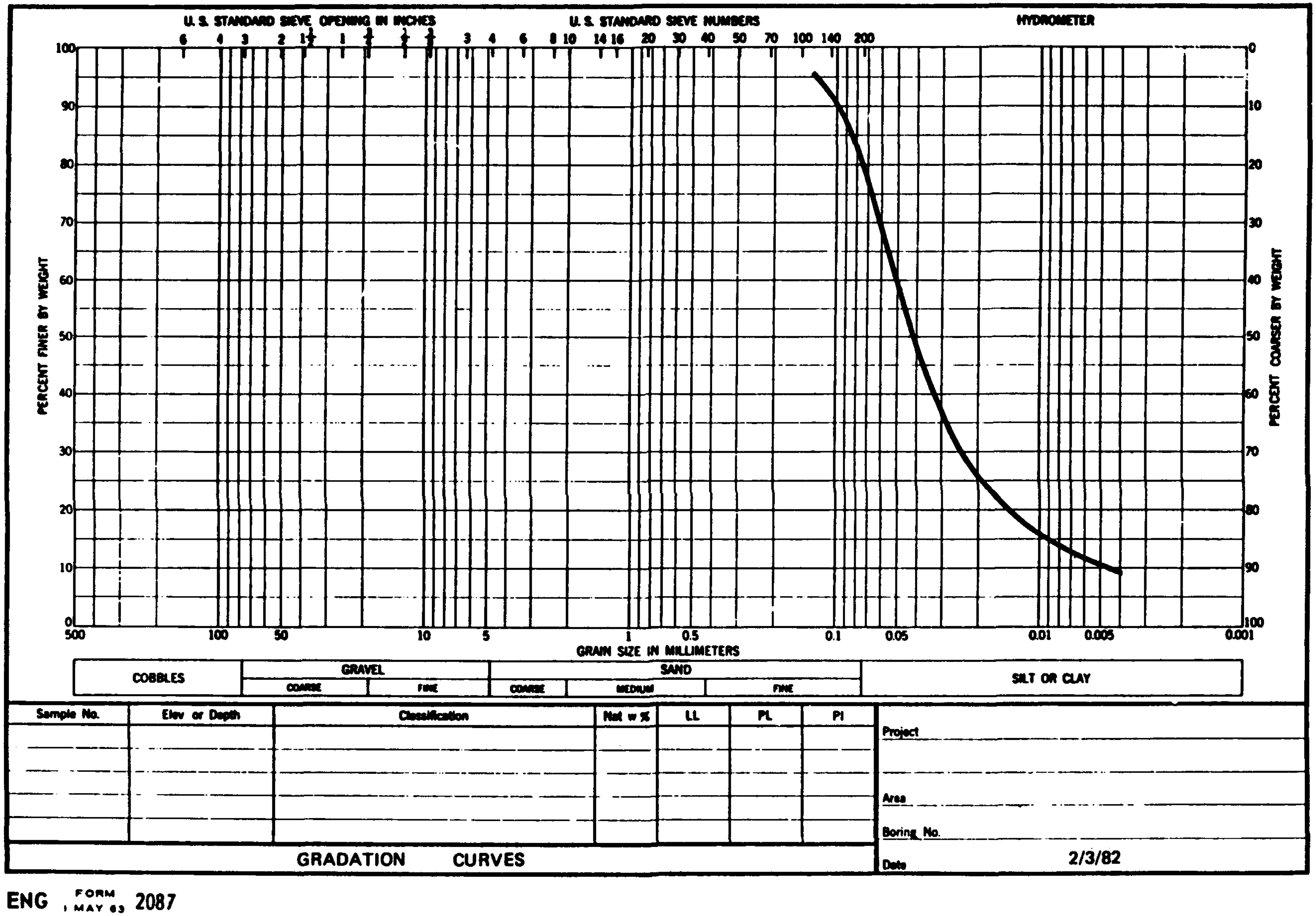

Figure 4. Composite bed gradation curve for all bay samples

limited information in that stations were indicated as clusters, however, specific station numbers were not identified.

16. The objective of this portion of the study was to generate information required by the WES numerical sediment transport modeling effort for the prediction of deltaic evolution. This objective was completed during the early stages of the overall project and reported in Report 5 in this series of reports. For this reason, there will be no summary and conclusions and the report will conclude with Part IV, Presentation of Selected Data.

PART IV: PRESENTATION OF SELECTED DATA

Tabulation of Percent Finer Than Classes

17. Table 1 presents the results of laboratory sieve and other analyses of 325 selected grab samples of the Atchafalaya Bay bed sediments. The table presents the sample number, date analyzed, grain size distribution, and sorting coefficient. The table has columns labeled by diameter (D) and percent finer. For example, D_{50} is the median (50 percent finer) diameter. For convenience, the data are shown in microns instead of millimeters.

18. The sorting coefficient is a measure of the spread about the mean, and was calculated as:

$$\textit{sorting coefficient} = \left| \frac{\phi_{84} - \phi_{16}}{4} + \frac{\phi_{95} - \phi_{5}}{6.6} \right|$$

where $\phi = -\log_2 D$

For example, a sorting coefficient of 6.39 indicates poorly sorted; whereas a coefficient of 1.86 indicates well sorted.

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Table 1

Grain Size Distribution of Field Sediment Samples

Sample	Date	Grain Size, microns, for Percent Finer Classes: D5	D16	D50	D84	D95	Sorting Coefficient
4	10-31-80	0.0	1.0	27.0	55.0	69.0	3.88
16	11-08-80	0.0	0.2	10.0	46.2	93.0	4.46
19	12-09-80	0.0	0.2	13.0	35.0	60.0	4.27
22	9-31-80	0.0	3.4	24.0	53.6	90.0	3.49
24	9-31-80	0.0	8.0	53.0	88.8	116.0	3.42
28	9-30-80	0.0	0.6	20.0	49.8	67.0	4.02
35	9-31-80	0.0	1.8	24.0	48.6	67.0	3.62
39	12-10-80	0.0	9.0	49.0	81.6	100.0	3.31
41	11-08-80	0.0	0.0	15.0	53.6	77.0	6.39
45	9-31-80	0.0	9.2	45.0	83.4	111.0	3.33
49	9-31-80	0.0	4.2	47.0	238.0	3174.0	4.73
50	12-10-80	0.0	0.2	19.0	48.8	65.0	4.41
51	9-31-80	0.0	0.0	15.0	44.6	67.0	6.29
52	11-08-80	0.0	0.6	27.0	55.0	69.0	4.07
53	12-10-80	0.0	0.4	20.0	57.0	70.0	4.23
54	12-10-80	0.0	0.2	15.0	47.6	66.0	4.40
56	11-18-80	0.0	0.0	13.0	64.2	185.0	6.64
58	12-10-80	0.0	4.0	40.0	66.2	92.0	3.51
60	12-10-80	0.0	0.0	10.0	31.0	55.0	6.12
62	11-13-80	0.0	0.4	23.0	52.0	132.0	4.33
65	11-12-80	0.0	0.8	33.0	63.2	88.0	4.06
69	12-10-80	0.0	5.2	49.0	91.2	131.0	3.61
71	12-10-80	0.0	38.4	73.0	93.2	104.0	2.84
72	12-08-80	0.0	0.0	15.0	43.8	78.0	6.32
76	11-13-80	0.0	0.0	29.0	60.0	93.0	6.47
80	12-10-80	0.0	0.8	25.0	61.8	88.0	4.06
83	12-10-80	0.0	0.0	17.0	61.4	116.0	6.53
84	11-08-80	0.0	0.4	20.0	53.8	70.0	4.21
85	12-10-80	6.0	84.2	233.0	367.6	2608.0	1.86

(Continued)

(Sheet 1 of 11)

Table 1 (Continued)

Sample	Date	Grain Size, microns, for Percent Finer Classes D5	D16	D50	D84	D95	Sorting Coefficient
87	12-10-80	0.0	4.8	38.0	62.2	71.0	3.37
89	12-10-80	0.0	0.4	26.0	68.6	99.0	4.37
90	11-08-80	0.0	0.0	11.0	40.4	67.0	6.25
92	11-08-80	0.0	0.8	42.0	72.6	99.0	4.14
98	12-10-80	0.0	2.0	205.0	475.8	3747.0	5.28
99	11-08-80	0.0	0.0	18.0	57.8	84.0	6.43
102	11-08-80	0.0	7.6	77.0	182.6	401.0	3.97
105	11-08-80	0.0	38.6	83.0	118.4	137.0	2.99
110	11-08-80	0.0	0.6	25.0	52.8	68.0	4.05
116	10-31-80	0.0	6.0	40.0	70.0	96.0	3.39
117	12-09-80	0.0	8.2	54.0	84.4	124.0	3.40
122	12-02-80	0.0	0.0	18.0	1325.4	1739.0	8.23
132	12-02-80	0.0	0.0	2.0	42.8	110.0	6.38
141	12-02-80	0.0	0.0	0.0	7.6	64.0	5.64
148	12-02-80	0.0	0.0	1.0	39.8	69.0	6.26
152	12-02-80	0.0	0.2	7.0	43.6	65.0	4.36
155	12-09-80	0.0	0.0	24.0	46.8	91.0	6.37
157	12-02-80	0.0	0.6	28.0	59.2	69.0	4.09
161	12-02-80	0.0	2.0	25.0	51.8	70.0	3.61
162	12-06-80	1.0	40.4	68.0	94.2	123.0	1.36
164	12-02-80	0.0	1.8	35.0	68.0	93.0	3.81
167	12-02-80	0.0	0.8	37.0	66.0	147.0	4.19
173	11-20-80	0.0	1.6	32.0	66.0	95.0	3.85
177	12-08-80	0.0	0.0	5.0	25.6	59.0	6.06
179	11-20-80	0.0	8.4	47.0	82.4	103.0	3.35
180	11-20-80	0.0	0.0	12.0	38.8	63.0	6.23
182	11-20-80	0.0	5.8	32.0	58.0	69.0	3.27
187	11-20-80	4.0	56.2	85.0	120.2	142.0	1.05
188	11-20-80	0.0	0.2	24.0	69.6	115.0	4.66
190	12-08-80	0.0	0.0	16.0	54.8	69.0	6.37
194	12-08-80	0.0	0.0	7.0	31.8	53.0	6.12

(Continued)

Table 1 (Continued)

		Grain Size, microns, for Percent Finer Classes					
Sample	Date	D5	D16	D50	D84	D95	Sorting Coefficient
199	12-02-80	0.0	9.8	62.0	112.0	139.0	3.47
206	12-08-80	0.0	0.0	12.0	45.4	67.0	6.30
208	12-08-80	0.0	5.4	58.0	91.0	114.0	3.56
212	12-08-80	0.0	0.0	13.0	85.4	1535.0	7.21
215	12-06-80	0.0	0.0	7.0	75.6	811.0	7.03
218	12-06-80	0.0	0.0	26.0	61.8	93.0	6.48
225	12-06-80	0.0	0.2	28.0	80.0	112.0	4.70
231	12-06-80	0.0	0.4	17.0	50.0	89.0	4.23
235	12-06-80	0.0	22.2	58.0	84.8	99.0	3.00
236	12-06-80	0.0	2.8	40.0	87.8	118.0	3.80
241	10-30-80	0.0	1.8	36.0	68.6	156.0	3.93
246	12-10-80	0.0	0.0	4.0	27.4	55.0	6.07
249	12-10-80	1.0	56.8	85.0	115.4	135.0	1.33
253	12-10-80	0.0	0.4	37.0	67.0	91.0	4.34
256	12-20-80	0.0	0.6	50.0	86.4	121.0	4.35
261	12-09-80	0.0	0.0	2.0	25.0	58.0	6.05
269	11-13-80	0.0	0.0	10.0	57.6	90.0	6.45
273	12-08-80	0.0	0.8	25.0	49.6	66.0	3.91
276	12-08-80	0.0	0.0	5.0	45.4	97.0	6.38
280	11-08-80	0.0	36.2	60.0	80.0	95.0	2.79
283	11-08-80	0.0	22.8	56.0	83.8	99.0	2.98
286	12-09-80	0.0	6.0	46.0	69.8	91.0	3.38
291	11-13-80	0.0	45.0	79.0	103.2	130.0	2.87
295	11-13-80	0.0	0.0	21.0	63.2	110.0	6.52
304	11-08-80	20.0	56.2	84.0	115.4	136.0	0.68
308	11-08-80	13.0	62.4	91.0	134.4	179.0	0.85
315	11-08-80	14.0	60.0	86.0	121.4	139.0	0.76
321	12-06-80	0.0	29.8	95.0	133.8	190.0	3.20
327	12-08-80	47.0	71.2	101.0	134.8	176.0	0.52
329	11-08-80	0.0	2.4	39.0	68.6	107.0	3.74
331	12-08-80	0.0	38.4	75.0	103.0	134.0	2.94

(Continued)

Table 1 (Continued)

Sample	Date	Grain Size, microns, for Percent Finer Classes: D5	D16	D50	D84	D95	Sorting Coefficient
334	11-13-80	3.0	54.8	78.0	111.0	135.0	1.09
339	11-13-80	0.0	36.2	70.0	106.0	135.0	2.97
343	11-13-80	0.0	16.2	50.0	78.4	103.0	3.09
346	11-20-80	0.0	24.4	74.0	104.8	136.0	3.11
347	11-20-80	0.0	17.6	67.0	102.8	135.0	3.22
350	12-08-80	0.0	7.6	53.0	98.2	132.0	3.50
351	12-08-80	0.0	19.4	65.0	98.8	127.0	3.16
352	11-20-80	5.0	57.2	89.0	128.4	147.0	1.03
353	11-13-80	0.0	6.4	43.0	83.2	107.0	3.46
354	12-08-80	0.0	0.0	11.0	38.4	85.0	6.29
355	11-13-80	1.0	55.8	84.0	122.2	146.0	1.37
356	11-20-80	0.0	25.2	58.0	96.0	131.0	3.06
357	11-20-80	0.0	8.4	49.0	83.8	100.0	3.35
360	12-06-80	0.0	17.6	66.0	97.0	120.0	3.17
361	12-08-80	0.0	6.2	53.0	85.4	117.0	3.50
364	11-13-80	0.0	9.4	55.0	89.6	105.0	3.34
372	11-13-80	0.0	12.4	54.0	93.6	125.0	3.29
374	12-08-80	0.0	0.0	15.0	47.4	69.0	6.32
375	12-08-80	0.0	0.6	29.0	51.6	72.0	4.05
377	12-08-80	0.0	0.0	15.0	46.6	72.0	6.32
378	11-13-80	0.0	0.0	9.0	41.4	91.0	6.33
380	12-02-80	0.0	0.6	25.0	54.8	70.0	4.07
381	12-06-80	0.0	6.0	35.0	67.0	92.0	3.37
383	12-06-80	0.0	16.4	52.0	64.6	70.0	2.93
385	12-08-80	0.0	0.0	13.0	41.4	63.0	6.25
386	11-20-80	0.0	0.8	25.0	52.6	69.0	3.95
387	12-06-80	0.0	5.4	46.0	88.8	107.0	3.54
388	11-20-80	0.0	7.0	37.0	65.8	88.0	3.30
391	11-20-80	0.0	2.0	26.0	57.8	74.0	3.66
392	11-20-80	0.0	2.0	27.0	62.8	89.0	3.73
395	12-06-80	0.0	4.2	39.0	69.0	93.0	3.51

(Continued)

Table 1 (Continued)

Sample	Date	Grain Size, microns, for Percent Finer Classes D5	D16	D50	D84	D95	Sorting Coefficient
399	12-10-80	0.0	21.8	67.0	96.0	107.0	3.07
400	12-10-80	0.0	19.4	75.0	99.2	130.0	3.16
403	10-30-80	4.0	38.4	80.0	105.2	133.0	1.13
405	10-30-80	0.0	2.6	32.0	66.0	86.0	3.65
406	10-30-80	0.0	2.4	20.0	54.4	82.0	3.60
407	10-30-80	0.0	10.8	43.0	71.0	95.0	3.18
408	12-10-80	0.0	1.0	30.0	58.0	72.0	3.91
410	10-30-80	25.0	62.6	88.0	125.2	411.0	0.86
412	12-10-80	34.0	76.0	111.0	140.0	178.0	0.58
420	10-30-80	0.0	1.8	23.0	57.8	71.0	3.69
424	12-10-80	0.0	21.6	55.0	83.6	99.0	3.00
428	10-30-80	0.0	0.4	30.0	66.0	89.0	4.33
434	10-30-80	0.0	10.8	62.0	94.2	104.0	3.31
435	12-10-80	0.0	9.4	66.0	99.0	127.0	3.42
440	12-10-80	0.0	4.0	49.0	85.6	113.0	3.65
441	12-10-80	0.0	3.0	56.0	97.8	130.0	3.83
446	12-02-80	0.0	12.4	54.0	66.6	71.0	3.05
457	12-10-80	0.0	0.2	15.0	52.6	78.0	4.47
470	12-10-80	0.0	0.6	26.0	65.6	94.0	4.20
485	12-02-80	0.0	0.2	13.0	51.6	74.0	4.45
493	12-10-80	0.0	2.6	37.0	86.0	120.0	3.82
496	12-10-80	0.0	0.6	31.0	72.6	103.0	4.25
499	12-10-80	0.0	0.4	18.0	54.2	85.0	4.25
502	12-10-80	0.0	7.6	50.0	83.4	104.0	3.39
505	6-02-81	2.0	45.8	74.0	107.0	135.0	1.23
506	6-02-81	0.0	12.4	56.0	98.4	133.0	3.33
507	6-02-81	0.0	3.8	46.0	60.6	66.0	3.42
508	6-02-81	0.0	2.8	28.0	61.6	94.0	3.62
509	6-02-81	0.0	2.8	44.0	65.2	92.0	3.63
510	6-02-81	0.0	8.6	46.0	79.4	114.0	3.35
511	6-02-81	0.0	31.8	68.0	94.2	119.0	2.95

(Continued)

Table 1 (Continued)

Sample	Date	Grain Size, microns, for Percent Finer Classes D5	D16	D50	D84	D95	Sorting Coefficient
512	6-02-81	0.0	18.0	61.0	96.8	132.0	3.18
513	6-02-81	0.0	10.2	45.0	84.6	110.0	3.30
514	6-02-81	0.0	13.8	72.0	116.0	142.0	3.36
515	6-02-81	0.0	1.8	36.0	93.8	139.0	4.01
516	6-02-81	0.0	23.0	75.0	108.8	135.0	3.14
517	6-02-81	0.0	30.2	77.0	103.6	134.0	3.03
518	6-02-81	10.0	69.6	107.0	135.0	146.0	0.82
519	6-02-81	11.0	62.2	103.0	133.0	144.0	0.84
520	6-02-81	5.0	54.0	93.0	126.8	140.0	1.04
521	6-02-81	0.0	32.8	70.0	95.2	128.0	2.95
522	6-02-81	0.0	8.4	44.0	75.4	101.0	3.31
523	6-02-81	0.0	3.8	44.0	59.6	66.0	3.42
524	6-02-81	0.0	0.0	5.0	33.2	62.0	6.17
525	6-03-81	0.0	0.0	7.0	39.8	80.0	6.29
526	6-03-81	0.0	0.0	7.0	53.2	527.0	6.80
528	6-03-81	0.0	2.4	41.0	98.6	146.0	3.94
529	6-03-81	0.0	3.8	45.0	84.8	113.0	3.66
530	6-04-81	0.0	4.0	34.0	65.8	95.0	3.52
531	6-03-81	0.0	13.0	45.0	83.4	116.0	3.22
532	6-03-81	0.0	11.4	47.0	80.4	100.0	3.22
533	6-03-81	0.0	16.0	52.0	84.6	100.0	3.12
534	6-10-81	0.0	9.2	44.0	78.4	107.0	3.30
535	6-04-81	3.0	33.6	71.0	98.2	129.0	1.21
536	6-04-81	0.0	14.4	52.0	94.6	120.0	3.24
537	6-04-81	0.0	15.8	49.0	86.6	120.0	3.17
538	6-04-81	0.0	18.0	50.0	80.2	113.0	3.08
539	6-04-81	0.0	25.8	60.0	93.8	129.0	3.04
540	6-04-81	4.0	52.6	88.0	122.8	138.0	1.08
541	6-04-81	0.0	0.4	16.0	53.4	82.0	4.24
542	6-04-81	0.0	15.2	61.0	100.4	132.0	3.26
543	6-04-81	0.0	7.4	43.0	87.6	120.0	3.45

(Continued)

Table 1 (Continued)

		Grain Size, microns, for Percent Finer Classes					
Sample	Date	D5	D16	D50	D84	D95	Sorting Coefficient
544	6-04-81	0.0	10.0	43.0	98.6	135.0	3.41
545	6-05-81	2.0	41.2	81.0	116.4	137.0	1.30
546	6-05-81	0.0	8.0	48.0	90.0	102.0	3.39
547	6-05-81	0.0	2.6	41.0	111.4	161.0	3.98
548	6-05-81	0.0	0.8	21.0	54.6	89.0	4.01
549	6-05-81	2.0	65.8	114.0	136.2	175.0	1.24
550	6-05-81	0.0	2.6	35.0	74.4	96.0	3.72
551	6-05-81	29.0	74.8	104.0	135.0	552.0	0.86
553	6-05-81	0.0	2.8	37.0	88.4	123.0	3.81
554	6-05-81	0.0	0.2	16.0	47.6	65.0	4.40
555	6-08-81	0.0	7.0	47.0	69.8	93.0	3.33
556	6-08-81	0.0	3.8	39.0	79.6	99.0	3.61
557	6-08-81	0.0	16.6	44.0	74.4	99.0	3.06
558	6-08-81	0.0	0.2	14.0	51.4	73.0	4.45
559	6-08-81	0.0	1.4	31.0	84.8	130.0	4.05
560	6-08-81	0.0	5.6	46.0	84.4	117.0	3.53
561	6-08-81	0.0	0.2	16.0	51.6	83.0	4.48
562	6-08-81	0.0	17.2	71.0	100.8	132.0	3.22
563	6-08-81	0.0	9.4	57.0	94.0	564.0	3.73
565	6-08-81	0.0	0.2	15.0	47.4	69.0	4.41
566	6-08-81	0.0	0.4	23.0	58.8	75.0	4.25
568	6-08-81	0.0	4.0	34.0	73.2	105.0	3.58
569	6-08-81	0.0	1.4	26.0	68.4	98.0	3.91
570	6-08-81	0.0	16.0	73.0	101.8	130.0	3.24
571	6-08-81	0.0	5.0	37.0	83.4	118.0	3.57
572	6-08-81	0.0	1.8	26.0	65.2	96.0	3.80
573	6-08-81	0.0	2.6	22.0	61.4	94.0	3.64
574	6-08-81	0.0	0.2	12.0	45.4	69.0	4.39
575	8-06-81	0.0	0.4	20.0	54.6	81.0	4.24
576	8-06-81	0.0	13.0	42.0	75.4	99.0	3.15
577	8-06-81	0.0	3.6	32.0	81.2	109.0	3.66

(Continued)

Table 1 (Continued)

		Grain Size, microns, for Percent Finer Classes					
Sample	Date	D5	D16	D50	D84	D95	Sorting Coefficient
578	8-06-81	0.0	2.4	27.0	72.2	99.0	3.74
579	8-06-81	0.0	2.6	23.0	64.2	98.0	3.67
580	8-06-81	0.0	1.4	22.0	58.6	81.0	3.82
581	8-06-81	0.0	1.4	16.0	47.4	72.0	3.72
582	8-06-81	0.0	0.4	15.0	43.4	67.0	4.12
583	8-06-81	0.0	0.2	14.0	46.4	70.0	4.40
584	8-06-81	0.0	0.2	16.0	53.6	73.0	4.46
585	8-06-81	0.0	2.6	22.0	59.6	88.0	3.62
586	8-06-81	1.0	5.8	39.0	84.8	108.0	1.99
587	8-06-81	0.0	2.8	27.0	68.4	96.0	3.66
588	6-10-81	0.0	17.6	51.0	87.8	103.0	3.10
589	6-10-81	0.0	4.6	31.0	71.4	100.0	3.51
590	6-10-81	0.0	4.0	31.0	74.2	101.0	3.57
591	6-10-81	0.0	7.0	44.0	80.2	103.0	3.40
592	6-10-81	0.0	2.6	34.0	69.6	96.0	3.69
593	6-10-81	0.0	5.2	37.0	68.8	100.0	3.45
594	6-10-81	8.0	56.4	93.0	132.6	149.0	0.95
595	6-10-81	3.0	34.2	75.0	105.0	137.0	1.24
596	6-10-81	3.0	51.0	85.0	120.4	141.0	1.15
597	6-10-81	0.0	28.4	72.0	105.8	134.0	3.05
598	6-10-81	0.0	30.6	71.0	107.6	140.0	3.04
599	6-10-81	0.0	25.6	81.0	135.6	183.0	3.25
600	6-10-81	35.0	63.6	94.0	132.6	150.0	0.58
601	6-10-81	0.0	0.4	20.0	47.6	69.0	4.16
602	6-10-81	0.0	6.4	60.0	99.8	128.0	3.56
603	6-10-81	0.0	0.0	14.0	43.2	72.0	6.29
604	6-10-81	0.0	0.4	19.0	51.6	70.0	4.19
605	6-10-81	0.0	0.6	19.0	48.6	69.0	4.02
606	6-10-81	0.0	0.0	16.0	66.8	112.0	6.55
607	6-10-81	0.0	20.0	63.0	98.0	127.0	3.14
608	6-10-81	0.0	5.2	40.0	79.6	99.0	3.50

(Continued)

Table 1 (Continued)

		Grain Size, microns, for Percent Finer Classes					
Sample	Date	D5	D16	D50	D84	D95	Sorting Coefficient
609	6-10-81	0.0	0.2	20.0	52.6	70.0	4.45
610	6-10-81	0.0	1.4	30.0	62.6	94.0	3.87
611	6-10-81	0.0	5.4	31.0	55.0	67.0	3.27
612	6-10-81	0.0	22.4	71.0	106.2	137.0	3.15
613	6-10-81	0.0	7.2	43.0	97.2	133.0	3.52
614	6-10-81	0.0	5.2	37.0	84.8	119.0	3.56
615	6-10-81	0.0	23.4	76.0	114.0	139.0	3.16
616	6-10-81	0.0	8.4	44.0	87.4	106.0	3.37
617	6-10-81	0.0	4.0	35.0	66.8	91.0	3.51
618	6-10-81	0.0	1.8	24.0	55.8	77.0	3.70
619	6-10-81	0.0	2.8	25.0	57.6	78.0	3.55
620	6-10-81	0.0	2.6	25.0	64.4	95.0	3.66
621	6-10-81	0.0	14.0	52.0	97.6	126.0	3.27
622	6-10-81	0.0	15.6	64.0	103.6	135.0	3.27
623	6-10-81	0.0	19.0	77.0	121.8	149.0	3.27
624	6-10-81	0.0	20.2	78.0	117.0	141.0	3.23
625	6-10-81	0.0	6.0	40.0	86.2	113.0	3.50
626	6-10-81	0.0	2.8	39.0	82.6	102.0	3.74
627	6-10-81	0.0	2.6	34.0	73.4	98.0	3.72
628	6-10-81	2.0	34.0	83.0	118.0	141.0	1.38
628	6-10-81	0.0	0.2	13.0	49.4	71.0	4.43
629	6-10-81	0.0	0.2	19.0	58.4	82.0	4.52
630	6-10-81	0.0	0.0	14.0	60.0	95.0	6.47
631	6-10-81	0.0	0.0	12.0	43.6	67.0	6.28
632	6-10-81	0.0	14.6	55.0	86.6	105.0	3.17
633	6-10-81	0.0	10.6	53.0	83.0	112.0	3.28
634	6-10-81	0.0	1.0	31.0	63.8	87.0	3.99
635	6-10-81	0.0	10.4	58.0	93.0	127.0	3.36
636	6-10-81	0.0	1.0	33.0	71.6	99.0	4.05
637	6-10-81	0.0	2.0	34.0	75.2	99.0	3.82
638	6-10-81	0.0	8.0	58.0	93.8	119.0	3.44

(Continued)

Table 1 (Continued)

Sample	Date	Grain Size, microns, for Percent Finer Classes					Sorting Coefficient
		D5	D16	D50	D84	D95	
639	6-10-81	0.0	3.6	30.0	62.6	93.0	3.53
640	6-10-81	0.0	5.2	33.0	62.0	84.0	3.37
641	6-10-81	0.0	0.8	25.0	63.8	91.0	4.08
701	6-10-81	30.0	58.6	83.0	114.0	140.0	0.58
702	6-10-81	0.0	21.4	56.0	82.4	101.0	3.01
703	6-10-81	0.0	17.8	55.0	88.8	119.0	3.13
704	6-10-81	0.0	14.0	48.0	79.0	109.0	3.16
705	6-10-81	0.0	2.2	36.0	72.6	106.0	3.79
706	6-10-81	0.0	0.8	36.0	92.8	131.0	4.29
707	6-10-81	0.0	7.2	42.0	94.0	129.0	3.50
708	6-10-81	0.0	1.0	27.0	62.6	91.0	3.99
709	6-10-81	0.0	0.8	30.0	63.0	89.0	4.07
710	6-10-81	0.0	2.8	30.0	59.8	76.0	3.56
711	6-10-81	0.0	7.6	50.0	84.6	104.0	3.39
712	6-10-81	0.0	0.4	25.0	66.6	97.0	4.35
713	6-10-81	0.0	0.6	24.0	70.4	101.0	4.24
714	6-10-81	0.0	1.4	20.0	57.6	85.0	3.82
715	6-10-81	0.0	0.6	24.0	62.8	92.0	4.18
716	6-10-81	0.0	0.4	20.0	50.4	78.0	4.21
717	6-10-81	0.0	5.0	31.0	61.8	84.0	3.39
718	6-10-81	0.0	2.8	29.0	58.8	73.0	3.55
719	6-10-81	0.0	0.2	29.0	62.2	74.0	4.52
722	9-22-81	0.0	0.4	33.0	109.4	158.0	4.64
726	9-16-81	0.0	1.0	38.0	74.6	99.0	4.07
727	9-16-81	0.0	4.0	37.0	74.4	98.0	3.57
728	9-16-81	0.0	6.4	49.0	82.6	111.0	3.46
729	9-16-81	0.0	2.2	36.0	66.0	94.0	3.73
730	9-22-81	0.0	3.2	46.0	86.4	123.0	3.75
731	9-22-81	0.0	4.6	46.0	64.4	105.0	3.48
732	9-16-81	0.0	7.8	52.0	81.6	107.0	3.38
733	9-16-81	0.0	8.6	53.0	84.6	108.0	3.36

(Continued)

Table 1 (Concluded)

		Grain Size, microns, for Percent Finer Classes					
Sample	Date	D5	D16	D50	D84	D95	Sorting Coefficient
734	9-16-81	0.0	7.6	51.0	83.4	110.0	3.40
735	9-16-81	0.0	4.4	46.0	80.6	124.0	3.61
736	9-22-81	0.0	3.6	45.0	79.4	99.0	3.63
738	9-09-81	0.0	3.6	42.0	77.2	110.0	3.64
739	9-09-81	0.0	0.8	35.0	70.8	100.0	4.13
740	9-16-81	0.0	0.4	35.0	70.0	96.0	4.37
741	9-22-81	0.0	0.2	28.0	71.4	103.0	4.64
743	9-22-81	0.0	0.0	18.0	53.4	80.0	6.39
744	9-22-81	0.0	1.0	25.0	56.8	71.0	3.90
745	9-16-81	0.0	0.0	19.0	55.6	81.0	6.41
746	9-22-81	0.0	1.8	31.0	76.0	102.0	3.87
747	9-22-81	0.0	2.8	43.0	86.6	115.0	3.78
748	9-22-81	0.0	1.0	31.0	76.4	101.0	4.08
749	9-22-81	0.0	0.4	28.0	73.2	99.0	4.39
750	9-22-81	0.0	0.6	30.0	72.4	97.0	4.24
751	9-22-81	0.0	0.4	20.0	50.6	87.0	4.23
752	9-22-81	0.0	0.0	11.0	41.2	67.0	6.26

(Concluded)